

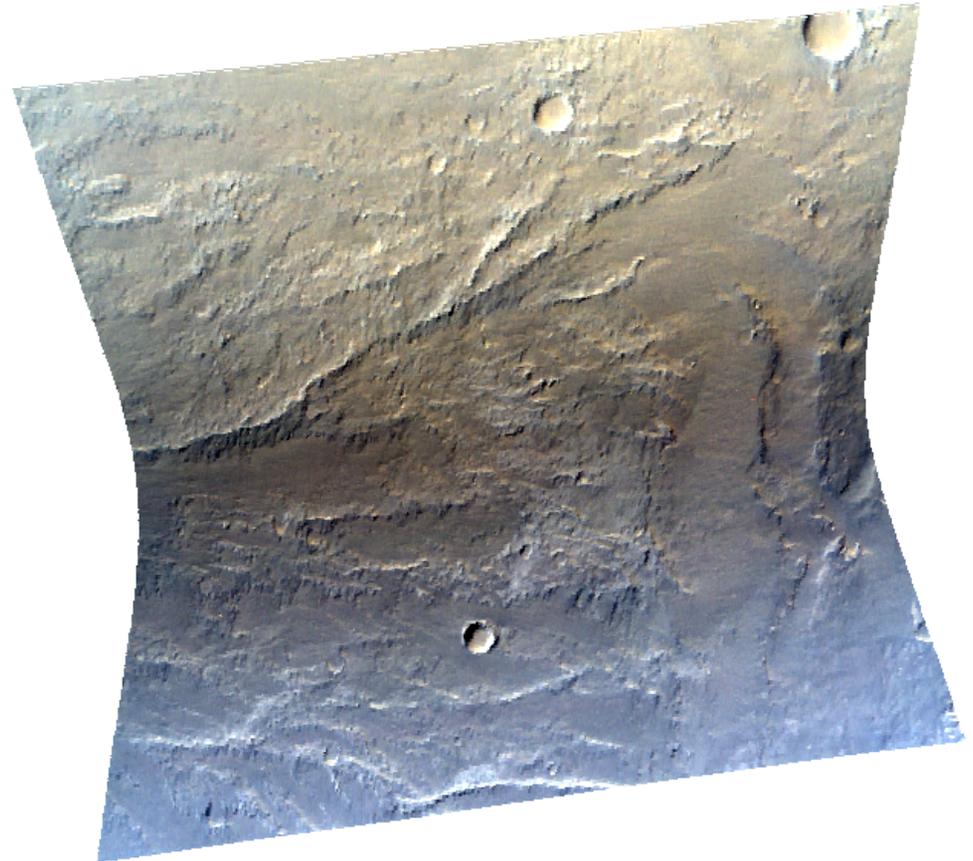
Mineral Abundances at MSL Candidate Landing Sites

Selby Cull, Ray Arvidson, Frank Seelos,
Francois Poulet, Bethany Ehlmann

4th MSL Landing Site Workshop
27 September 2010

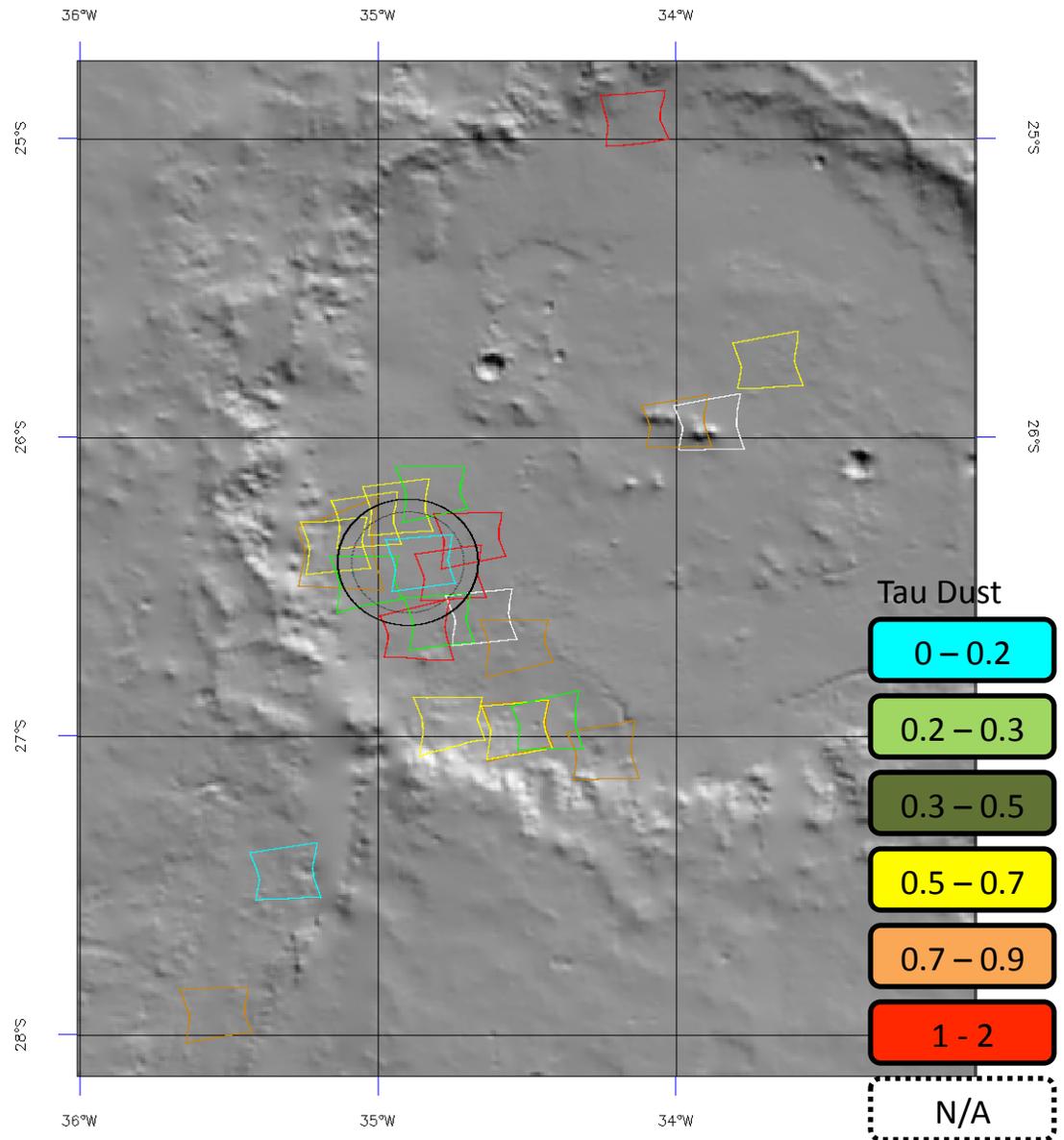
How Much Is There?

- CRISM can identify hydrated and hydroxylated minerals
- Here, we show that we can use CRISM to estimate the **relative abundances of minerals**
- Overview:
 - How we do it
 - Preliminary Results



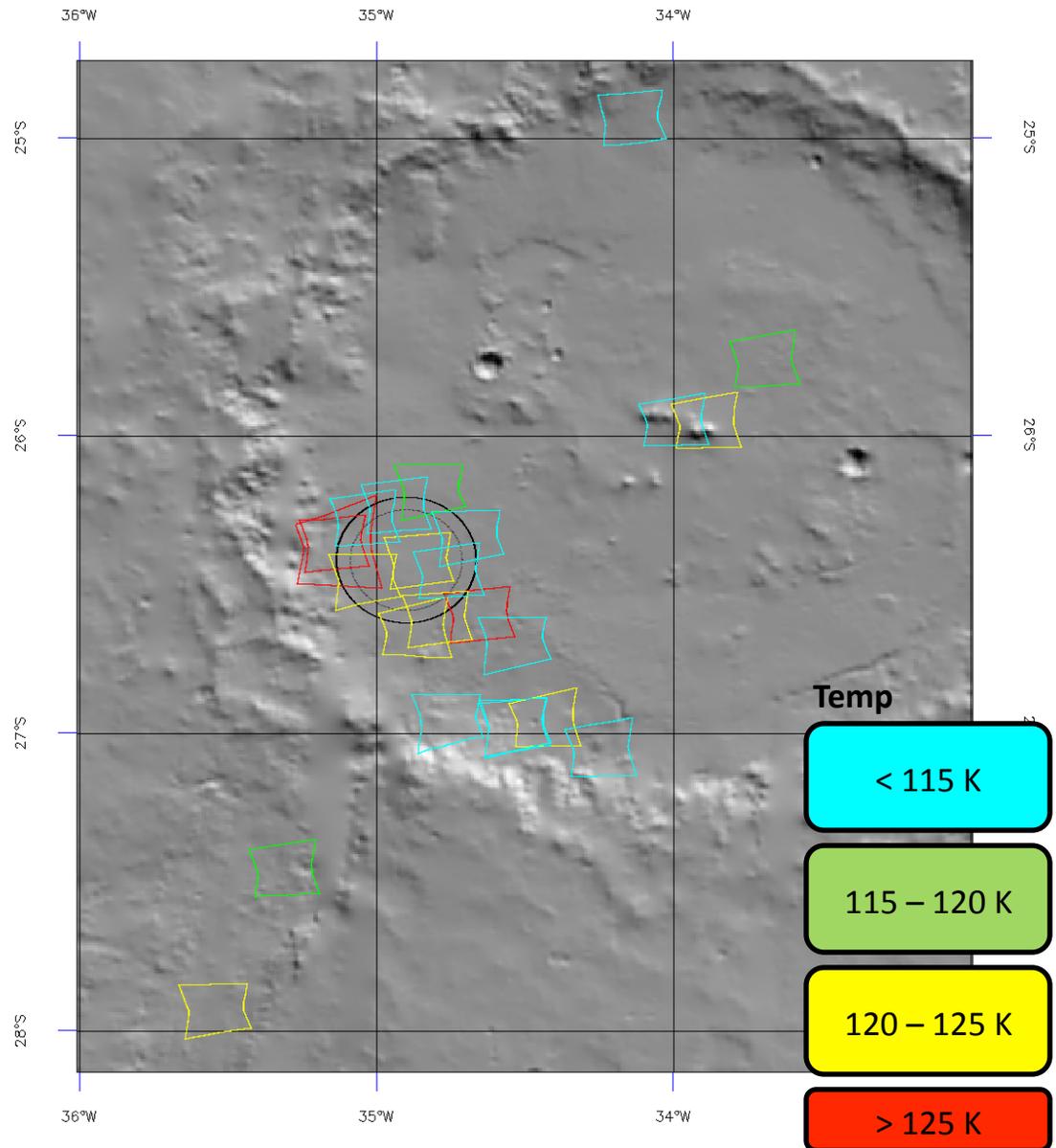
The Process

1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes



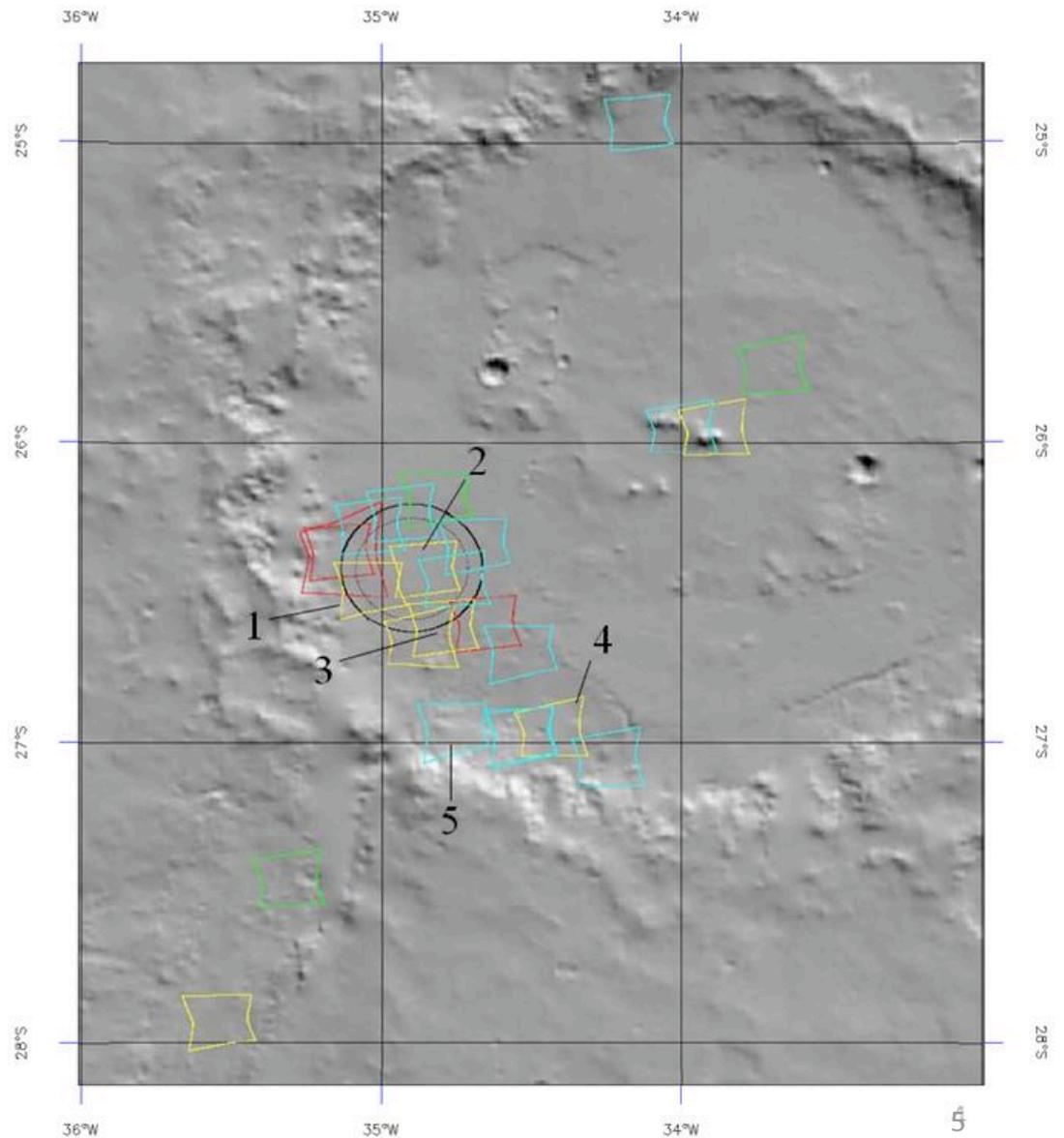
The Process

1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes



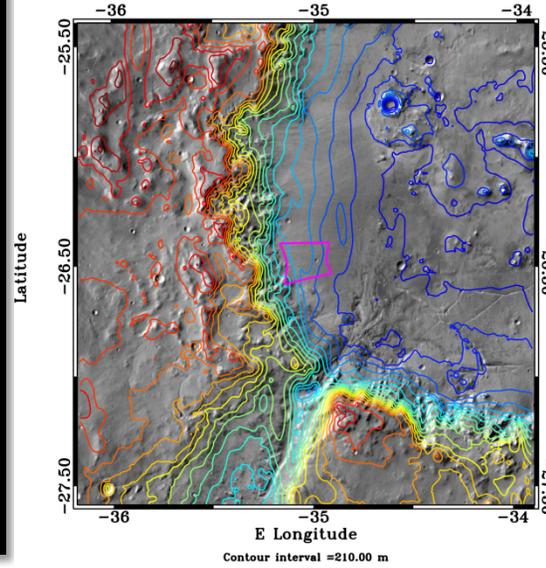
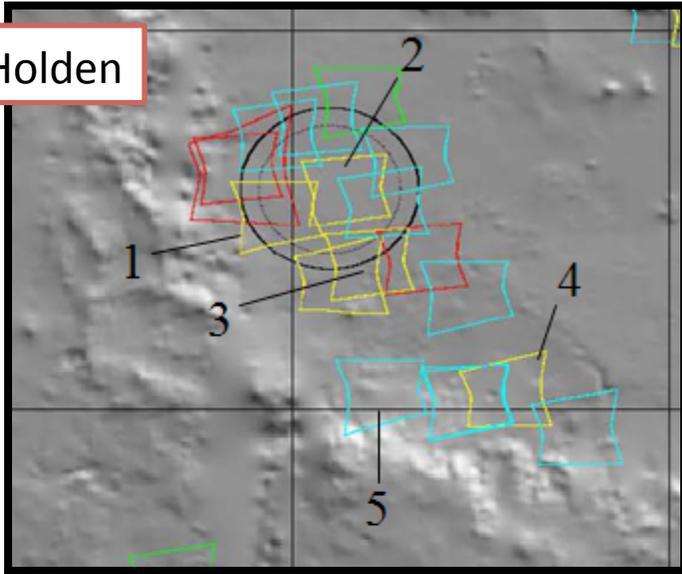
The Process

1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes

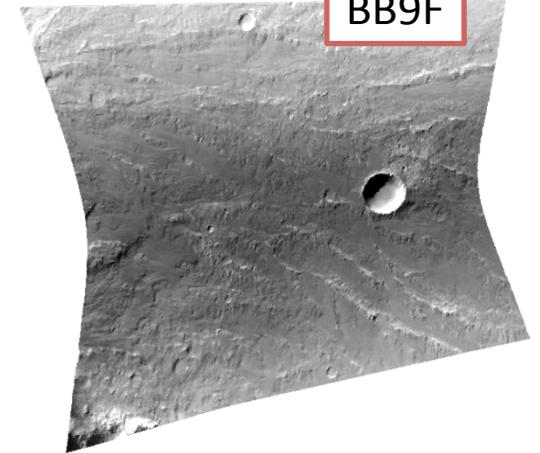


The Process

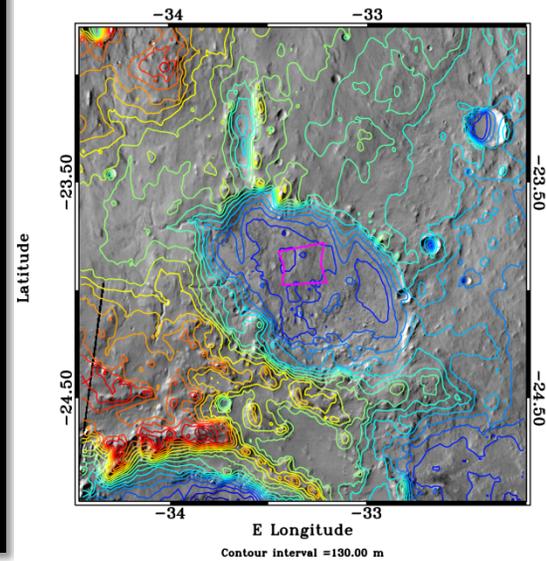
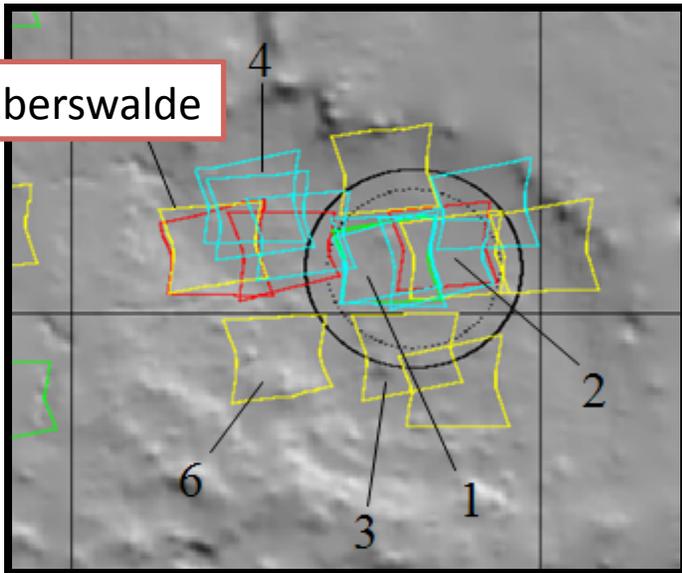
Holden



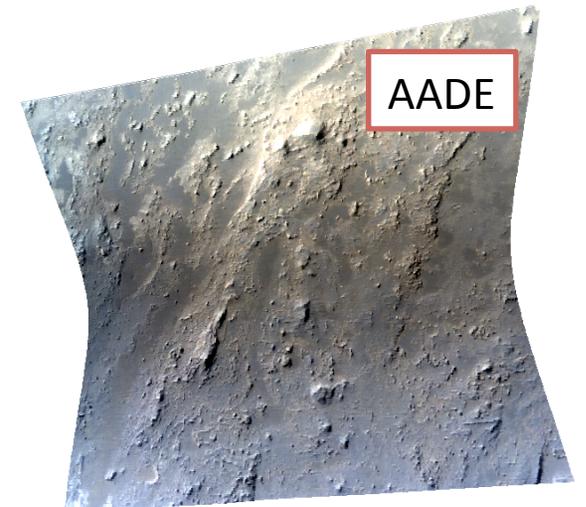
BB9F



Eberswalde

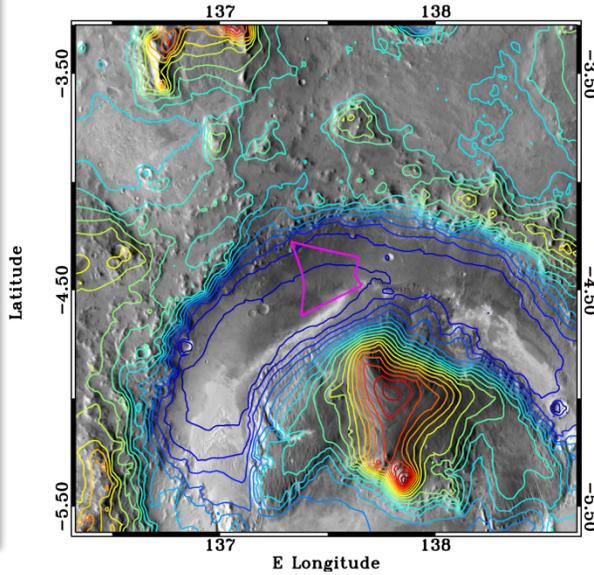
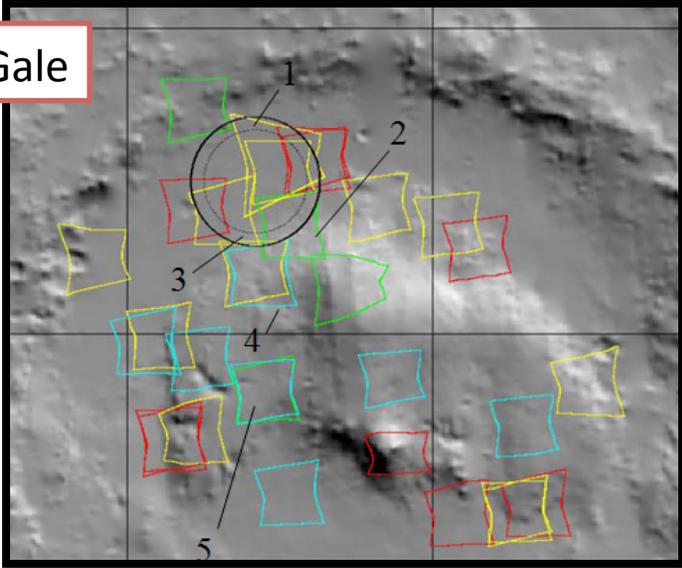


AADE

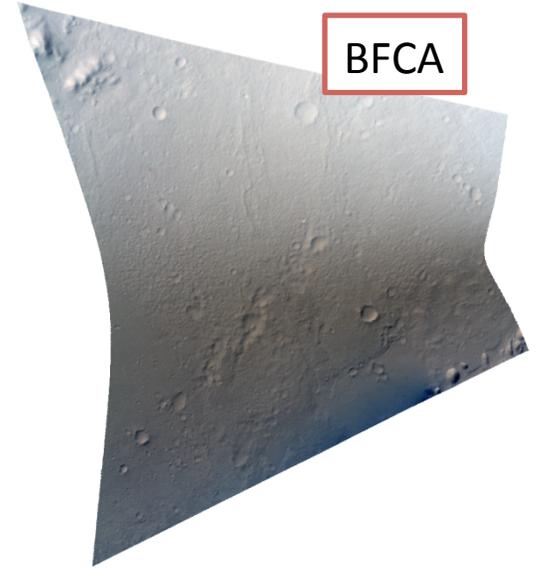


The Process

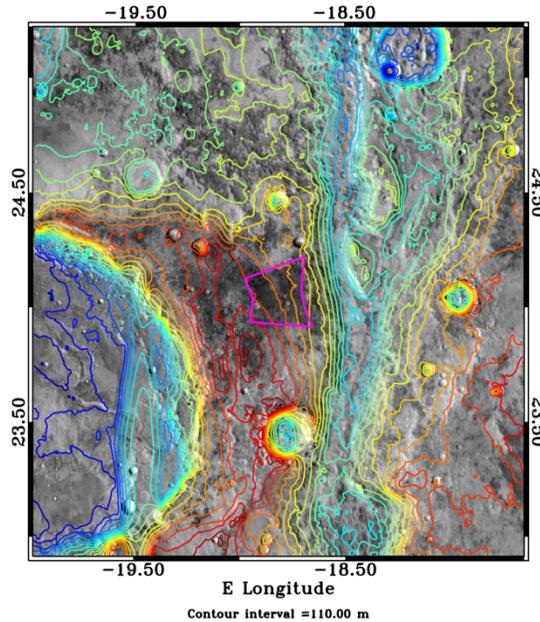
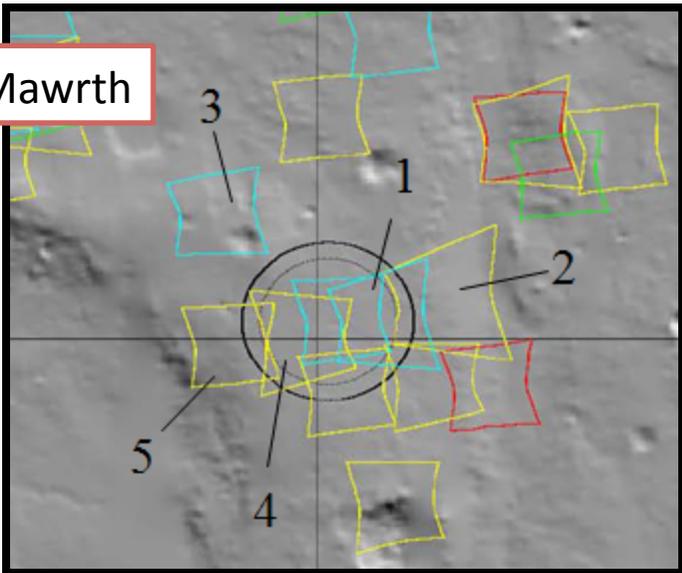
Gale



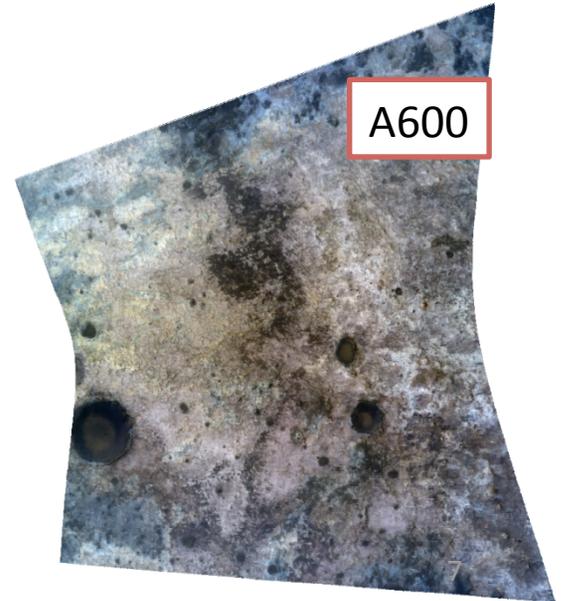
BFCA



Mawrth

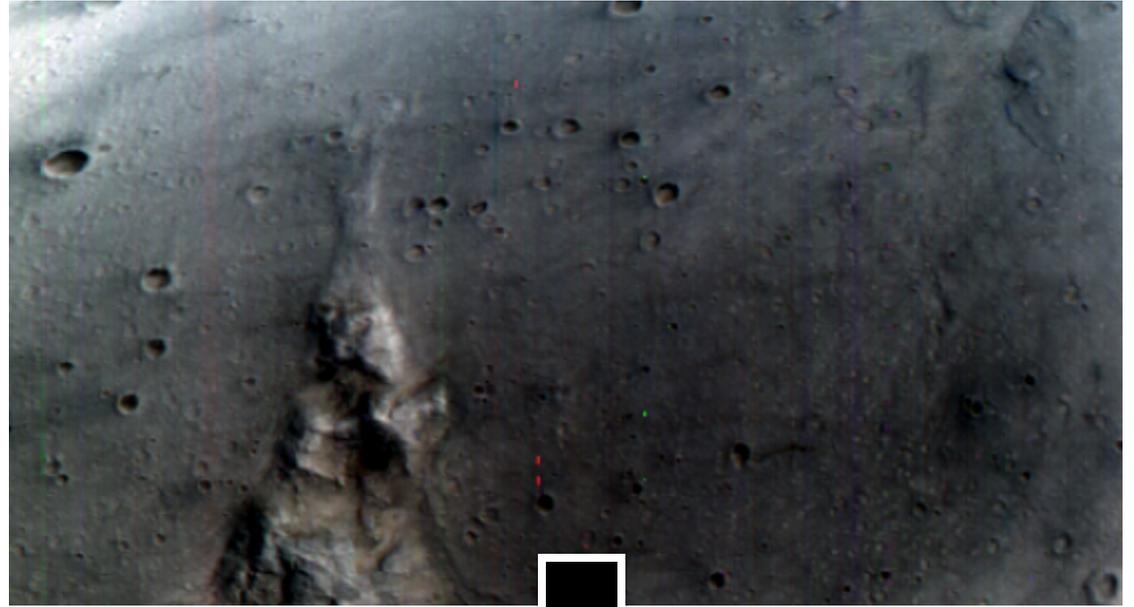


A600



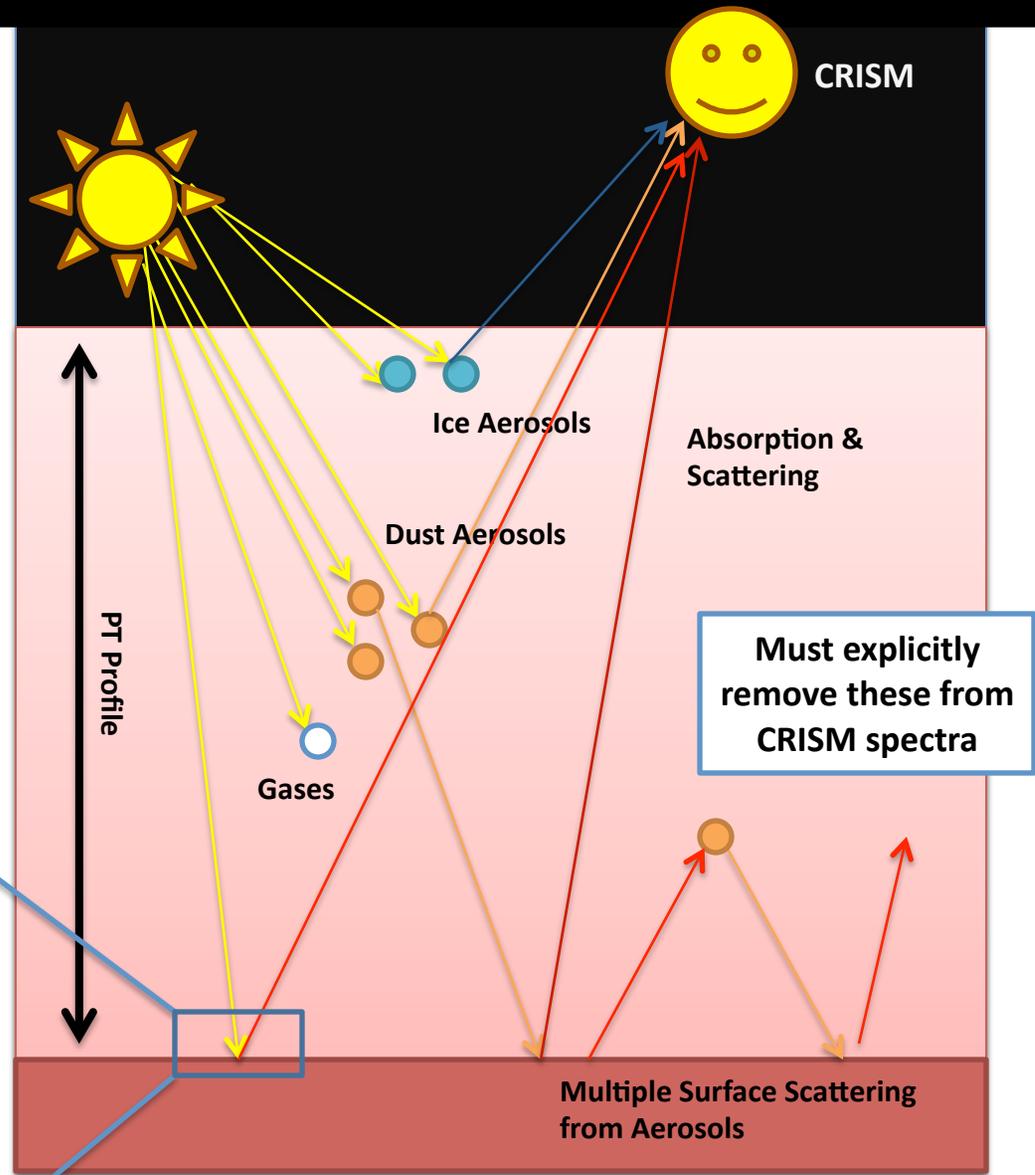
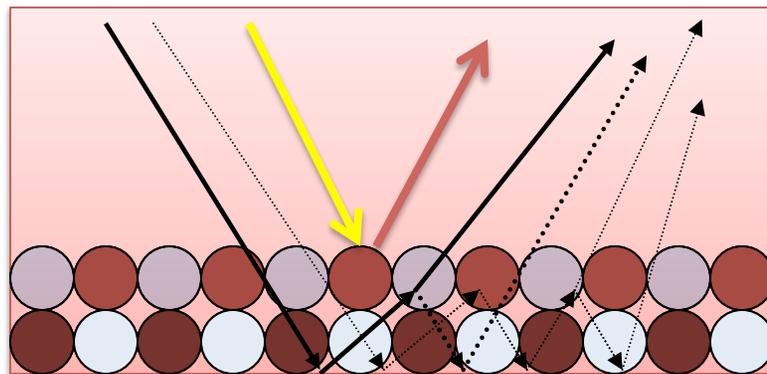
The Process

1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes



The Process

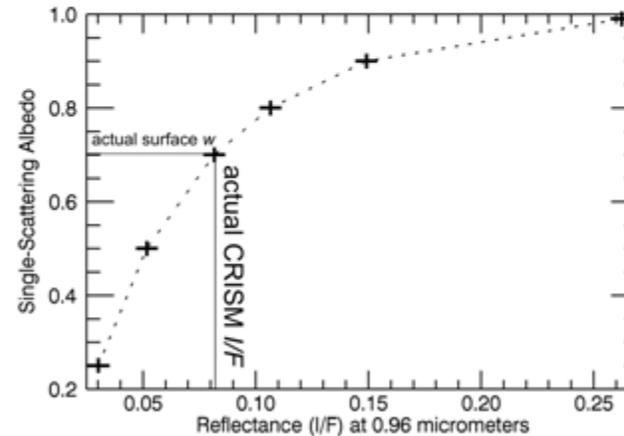
1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes



Multiple Scattering

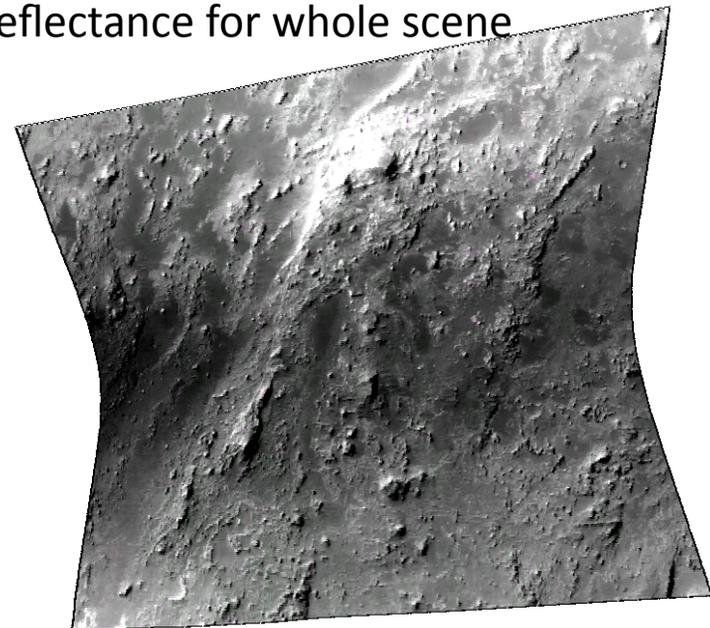
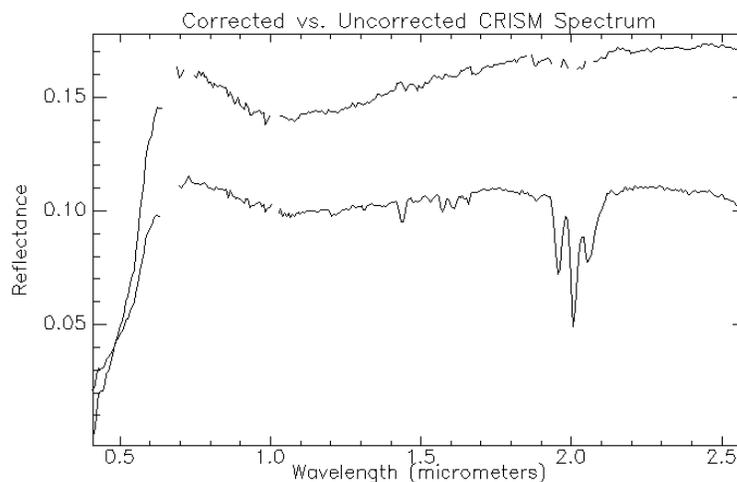
The Process

1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes



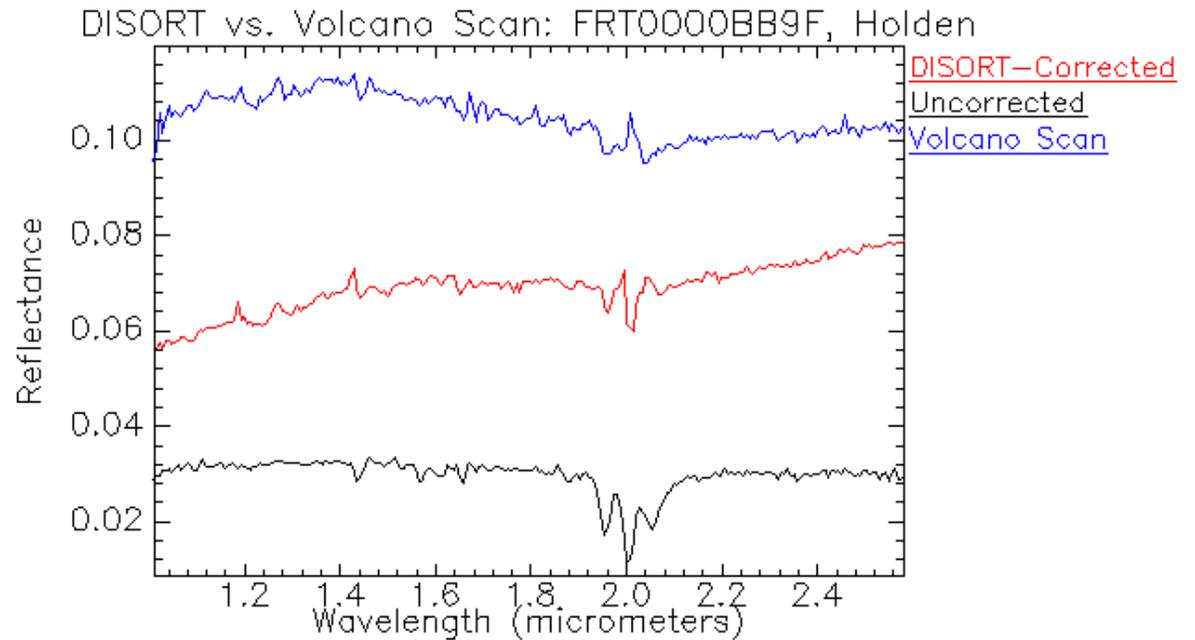
Look-Up Table:
Modeled I/F vs.
Model Surface w ,
for each wavelength,
for each pixel in FRT

Single-scattering albedo \rightarrow bidirectional reflectance for whole scene



The Process

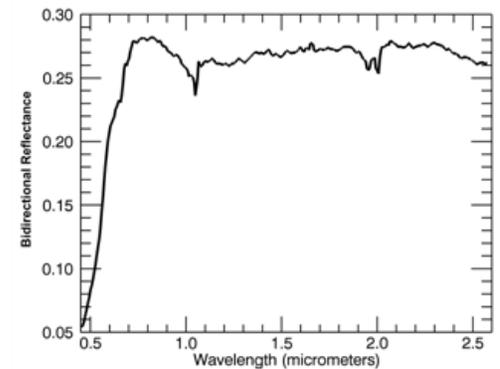
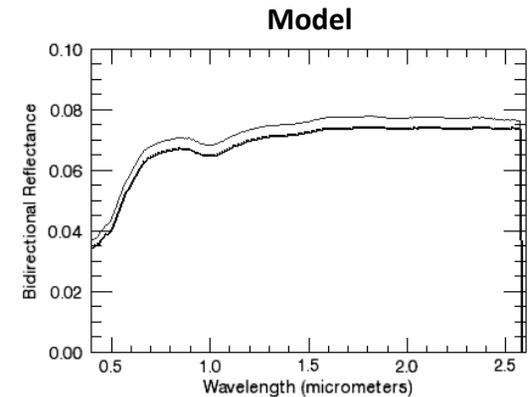
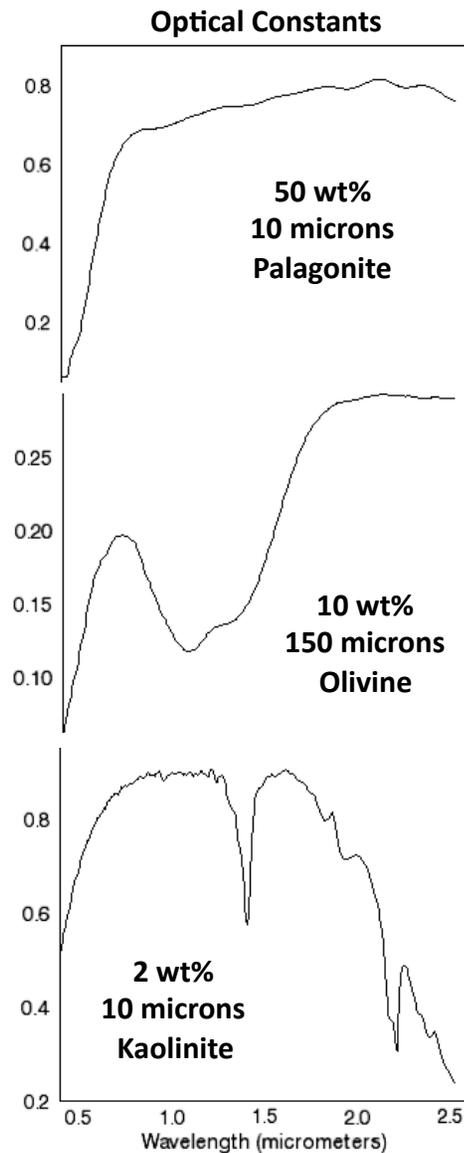
1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes



	DISORT Method	Volcano Scan
Variable aerosols	Yes	No
Explicit treatment of gases	Yes	No
Non-isotropic surface	Yes	No
Suitable for single-scattering albedo retrieval	Yes	No
Suitable for mineral abundance retrieval	Yes	No
Suitable for mineral identification	Yes	Yes
Quick	No	Yes

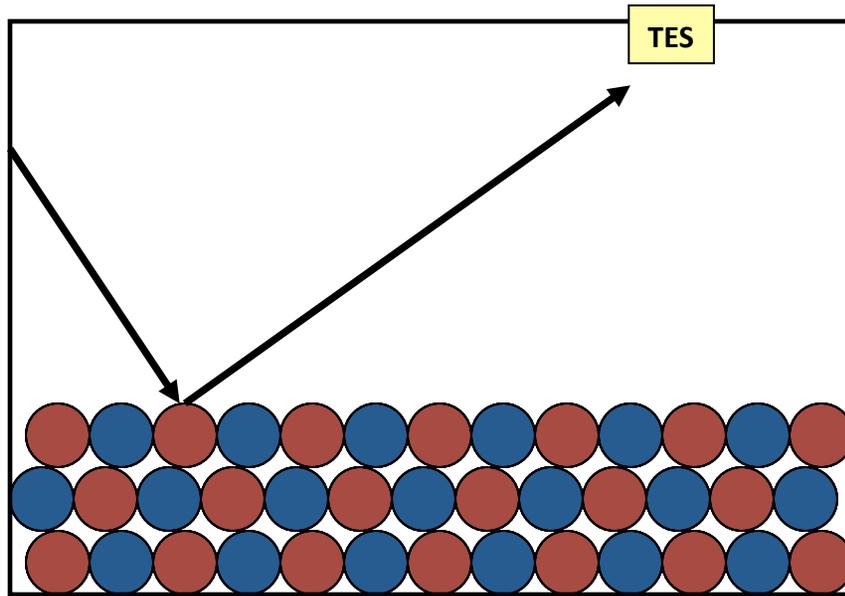
The Process

1. Cube Selection
2. New TRR3s from Frank Seelos
3. Atmospheric Correction
4. Mixing model to retrieve relative abundances and grain sizes

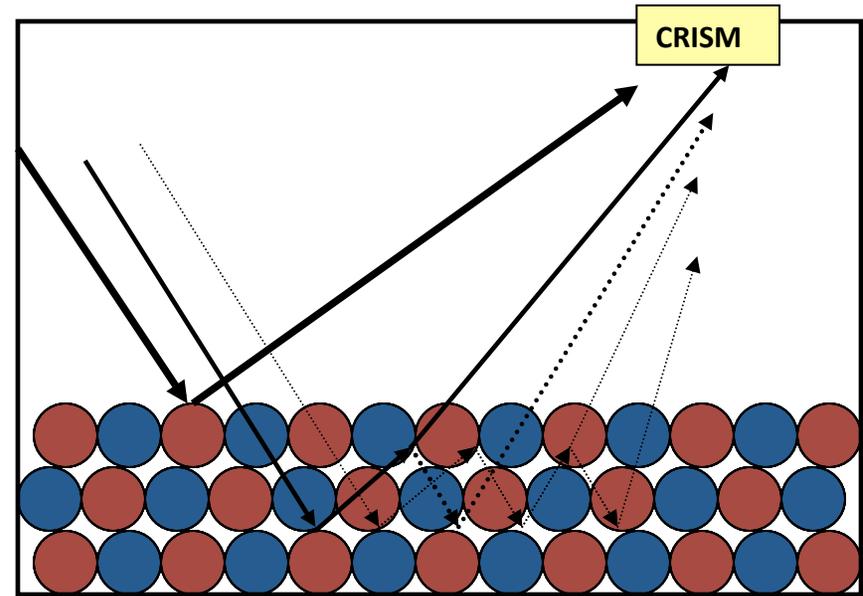


Iterate Least Square Fitting

The Process



Linear Mixing of Components



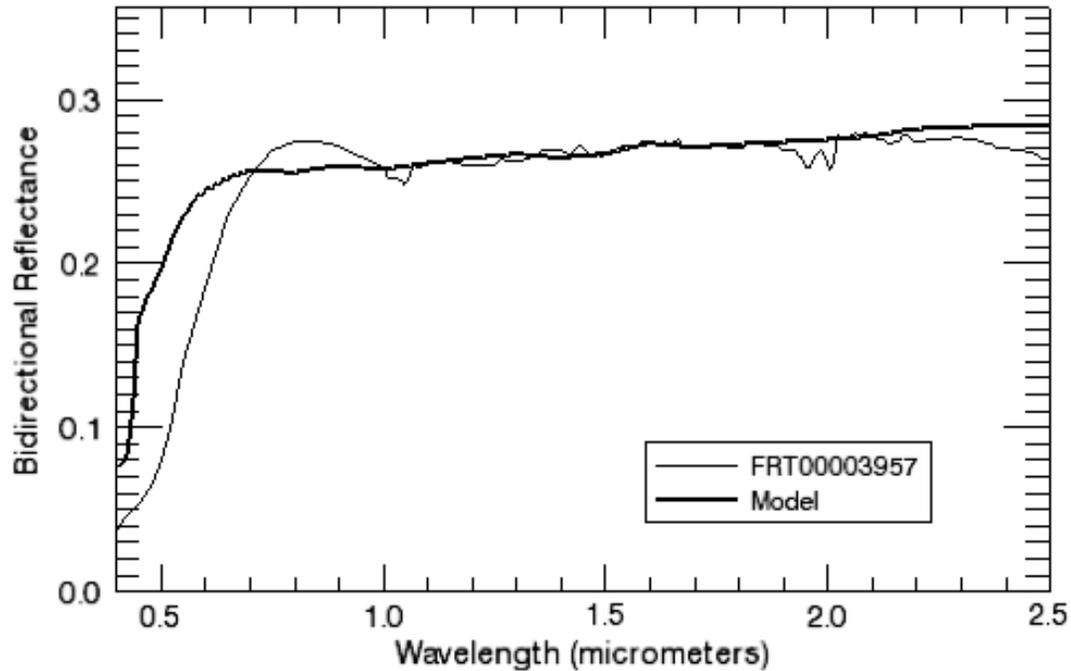
Reflectance depends on:

- Real & imaginary indices of refraction
- Viewing geometry
- Packing

Non-Linear Mixing Models

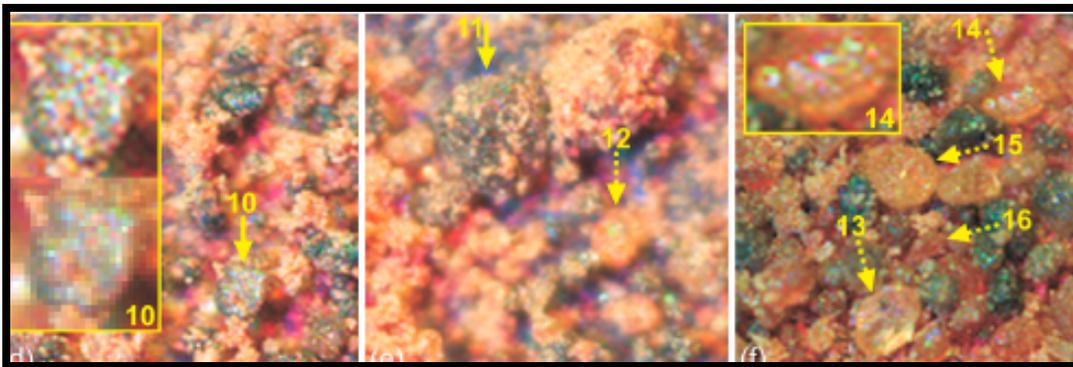
1. Hapke
2. Shkuratov
3. Mischenko

Ground Truth



Phoenix Landing Site

- Model Results:
 - Best fit: 44% Palagonite (4 microns) + 56% Basalt (60 microns)

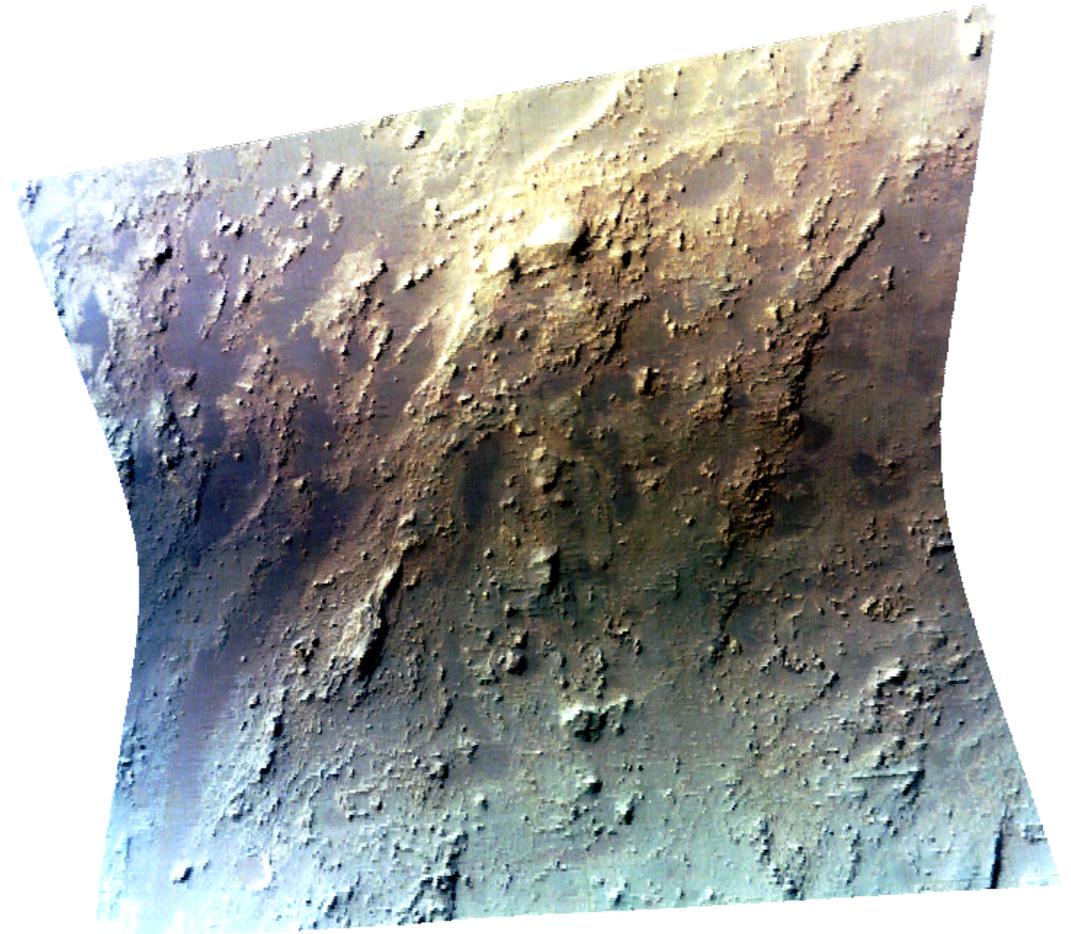


- Ground Measurements:
 - Mean grain size \sim 50 microns, with large dust component (Goetz et al. 2010, JGR)

Goal: Relative Abundances

Work to Date:

- Validation of Ratioing
- Preliminary Modeling Results



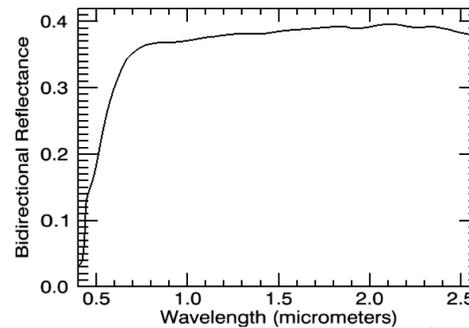
FRT0000AADE, Eberswalde

Goal: Relative Abundances

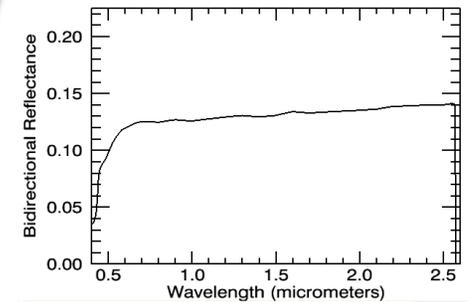
Work to Date:

- Validation of Ratioing
- Preliminary Modeling Results

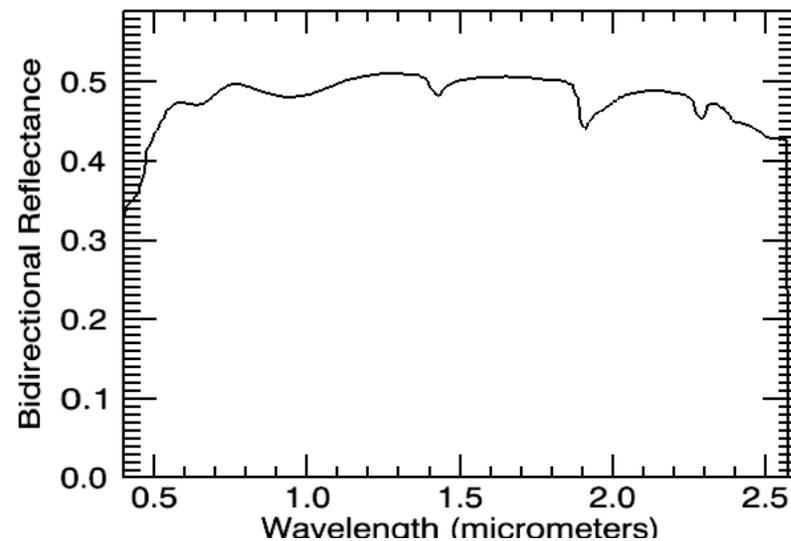
Spectrum that might have hydrated mineral



Featureless spectrum



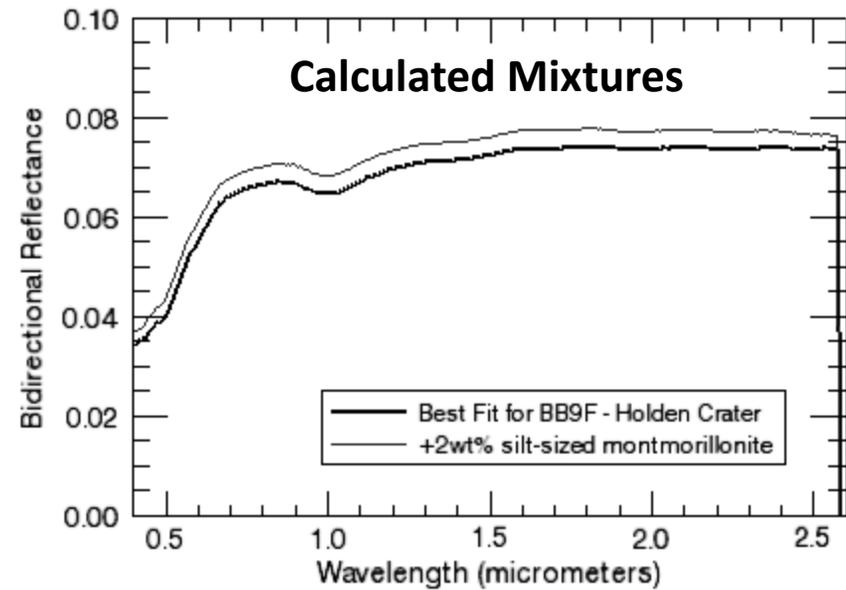
||



Goal: Relative Abundances

Work to Date:

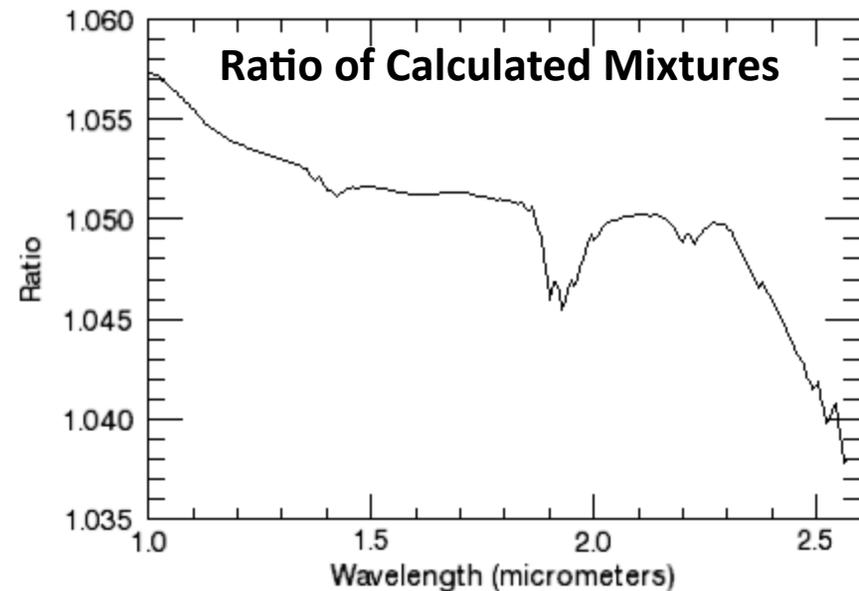
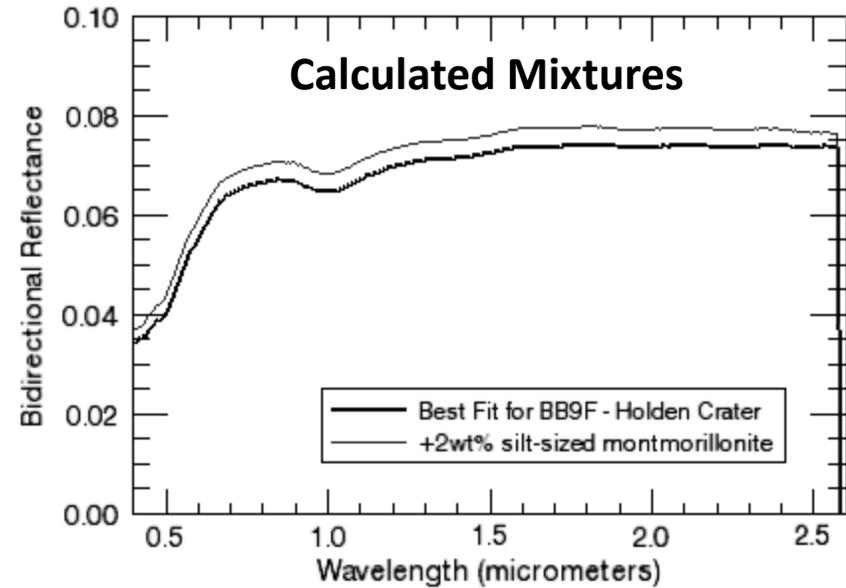
- Validation of Ratioing
- Preliminary Modeling Results



Goal: Relative Abundances

Work to Date:

- Validation of Ratioing
- Preliminary Modeling Results

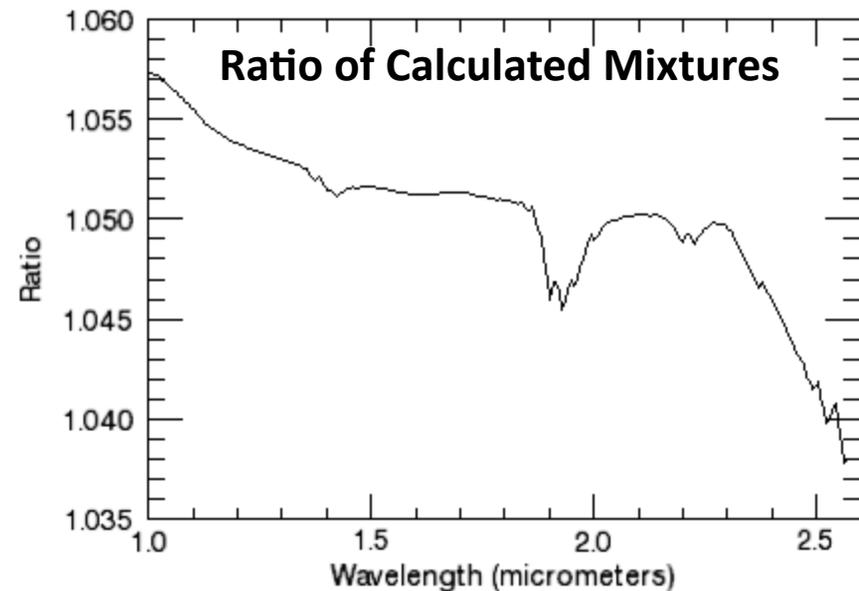
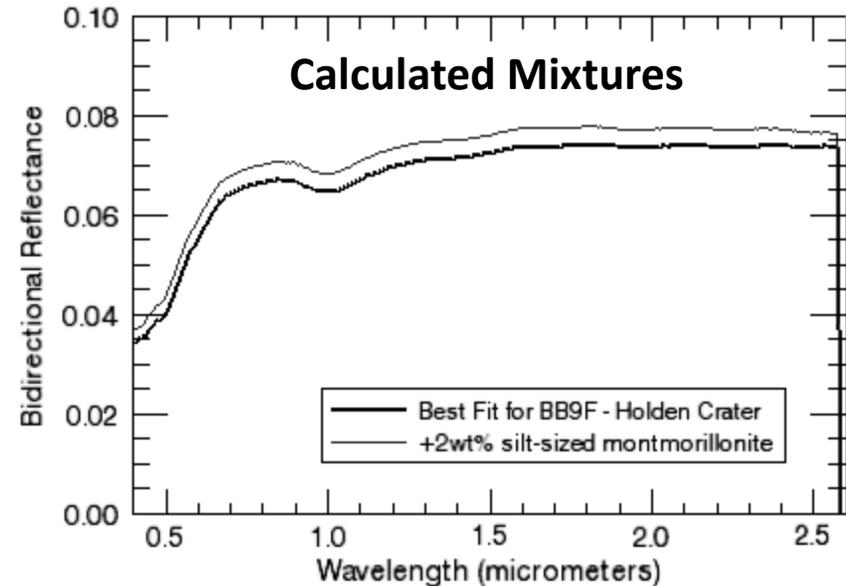


Goal: Relative Abundances

Work to Date:

- Validation of Ratioing
- Preliminary Modeling Results

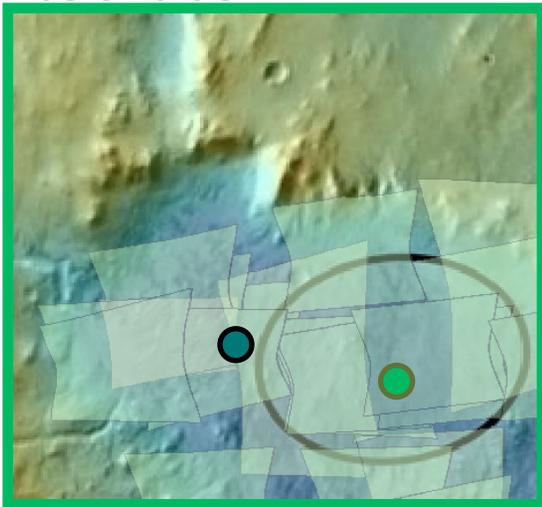
Ratioing is a valid method for pulling out mineral features



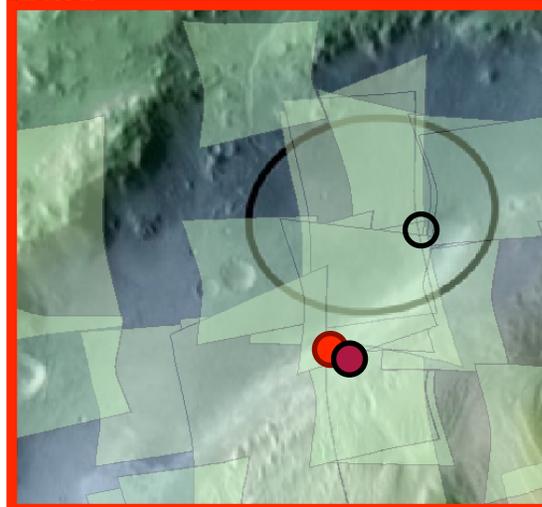
MSL site comparison of CRISM spectra

B. Ehlmann

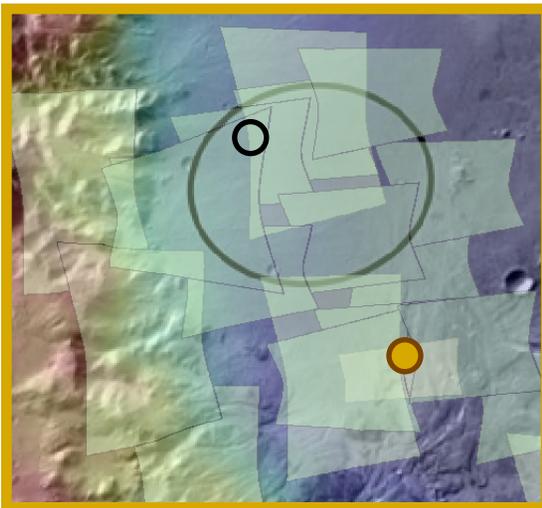
Eberswalde



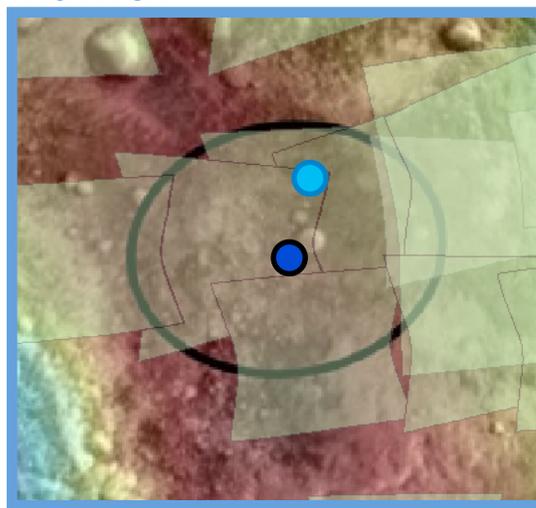
Gale



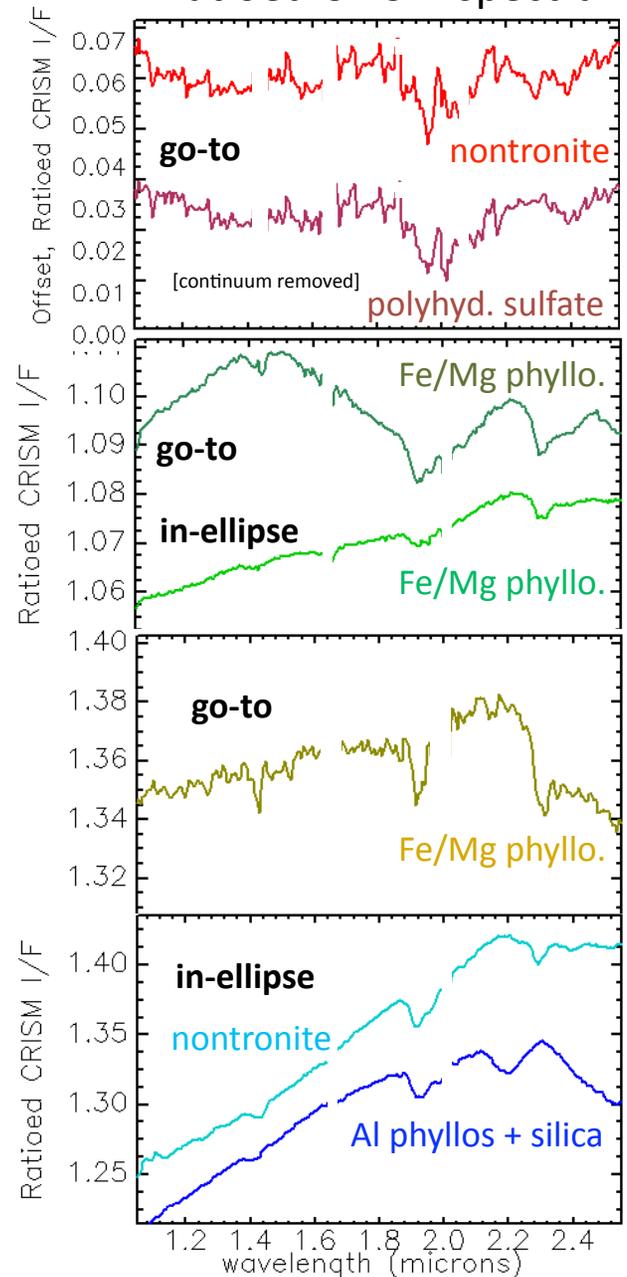
Holden



Mawrth

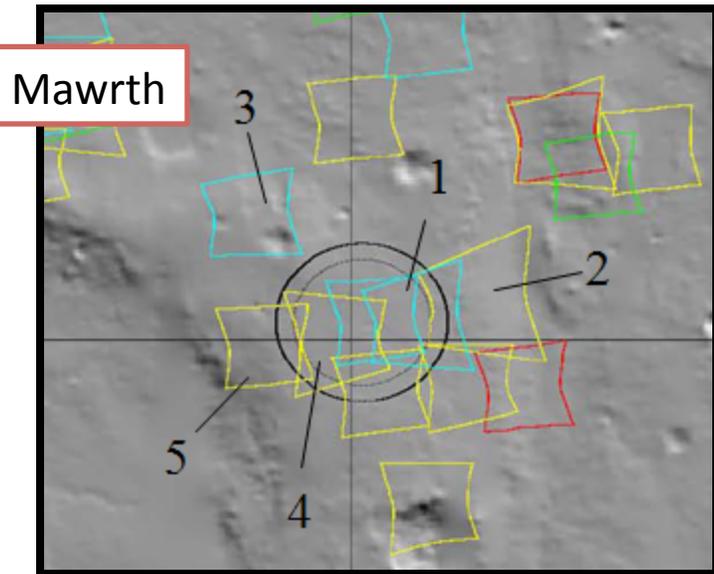
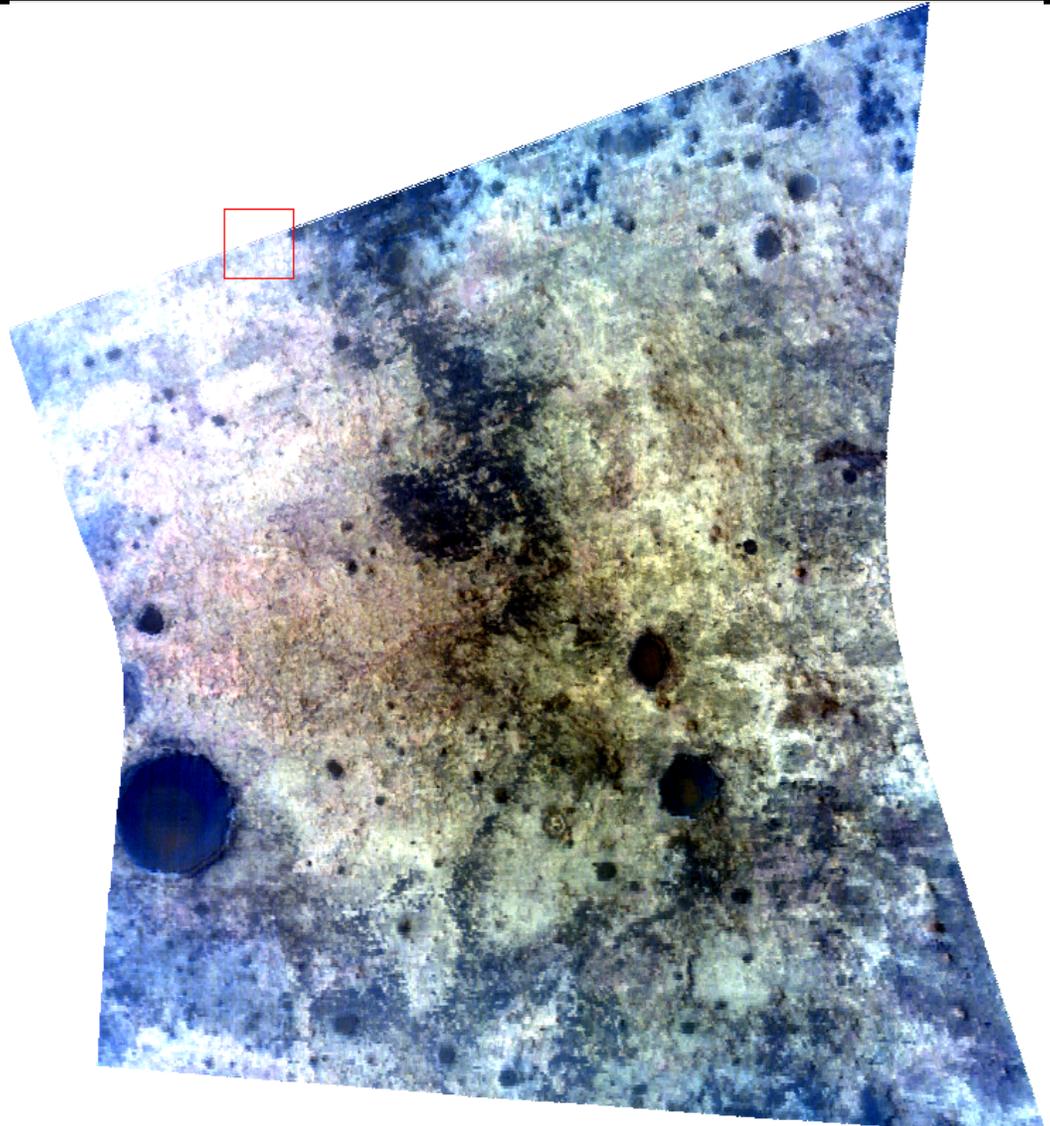
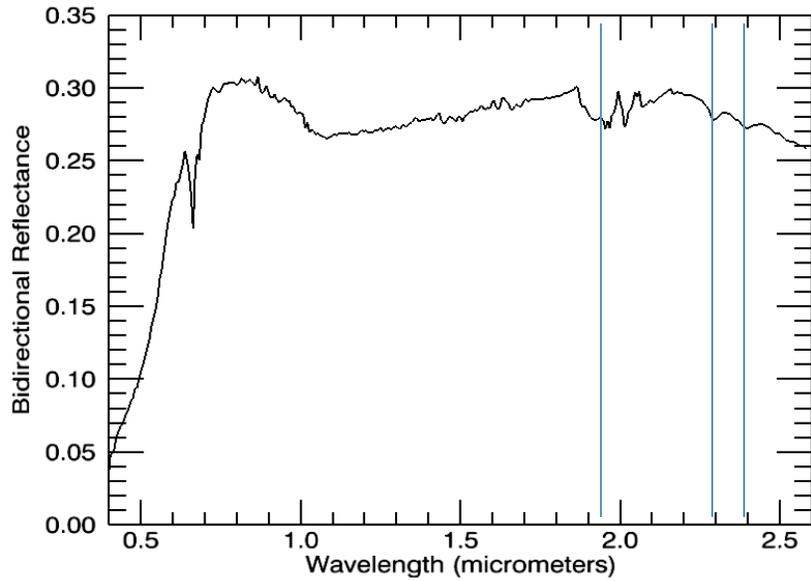


Ratioed CRISM spectra

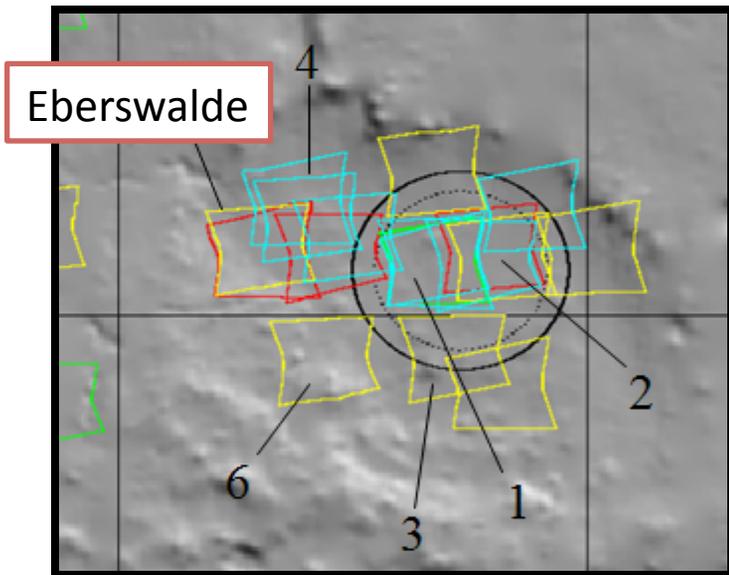
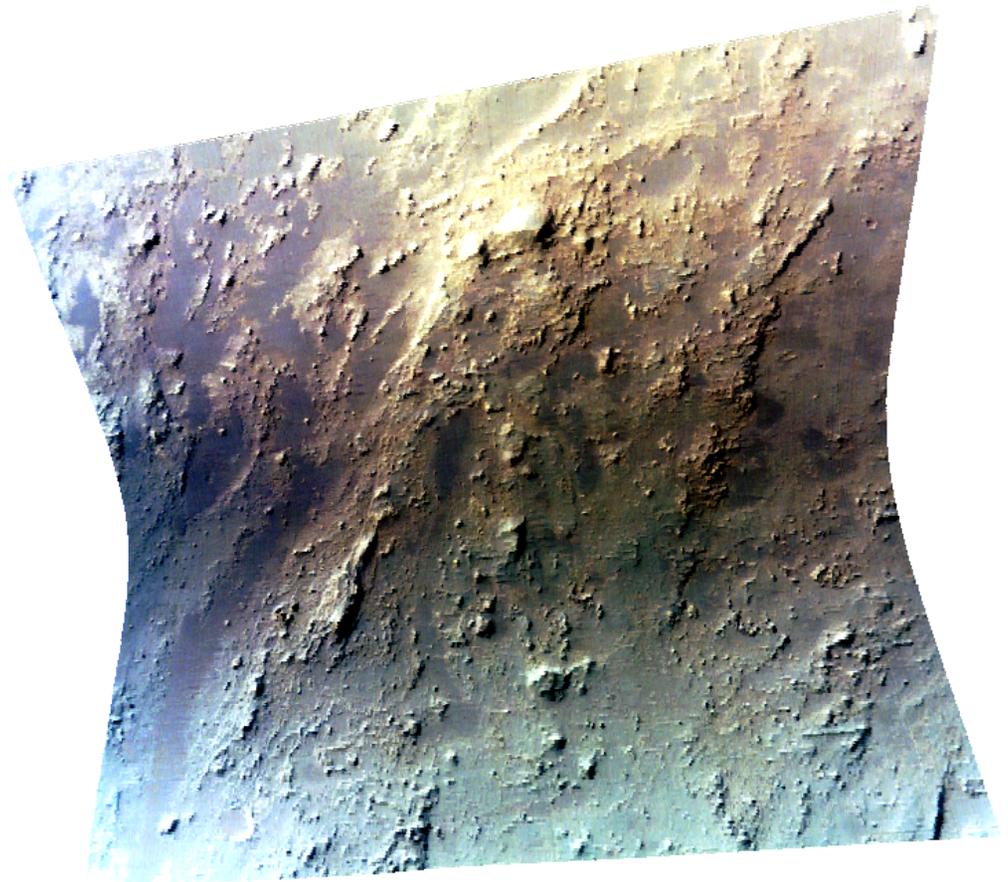
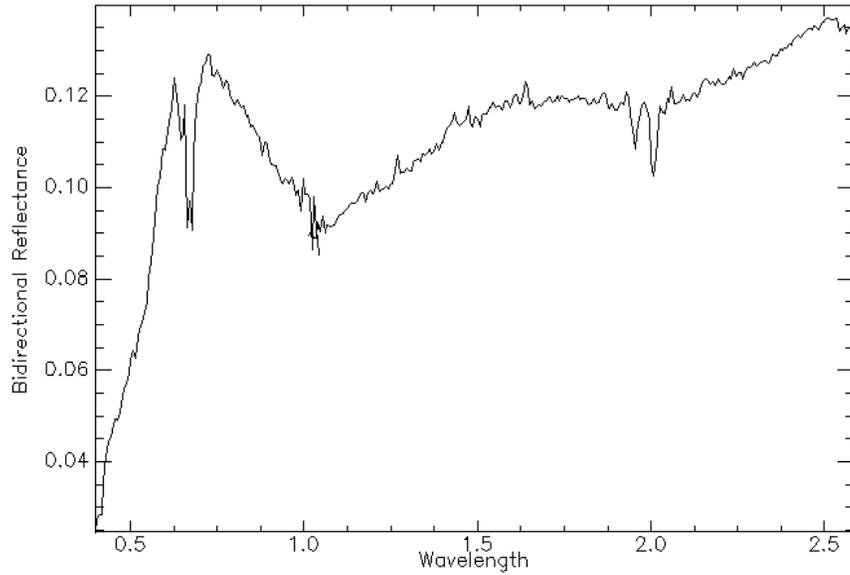


SPECTRA EXTRACTED FROM CRISM IMAGES-- Eberswalde: 8038 (in), 60DD (out);
 Gale: BEE7 (in), 58A3 (out); Holden: 9D17 (in), 30AF (out); Mawrth: 89F7 (in)

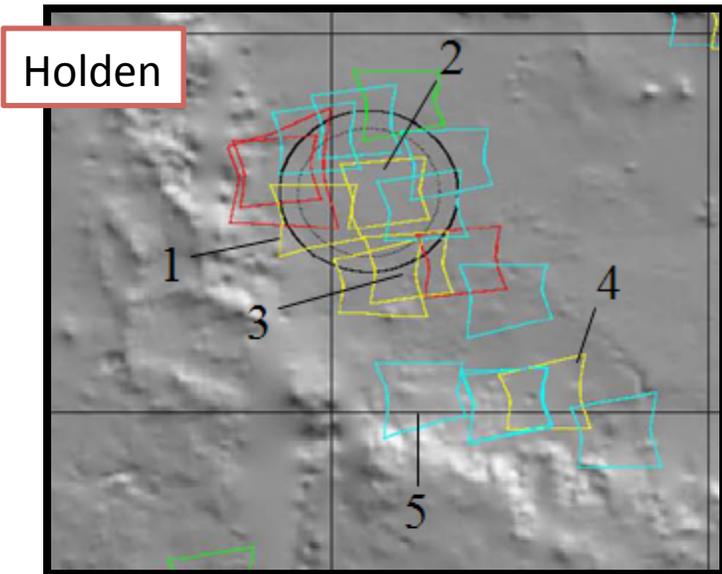
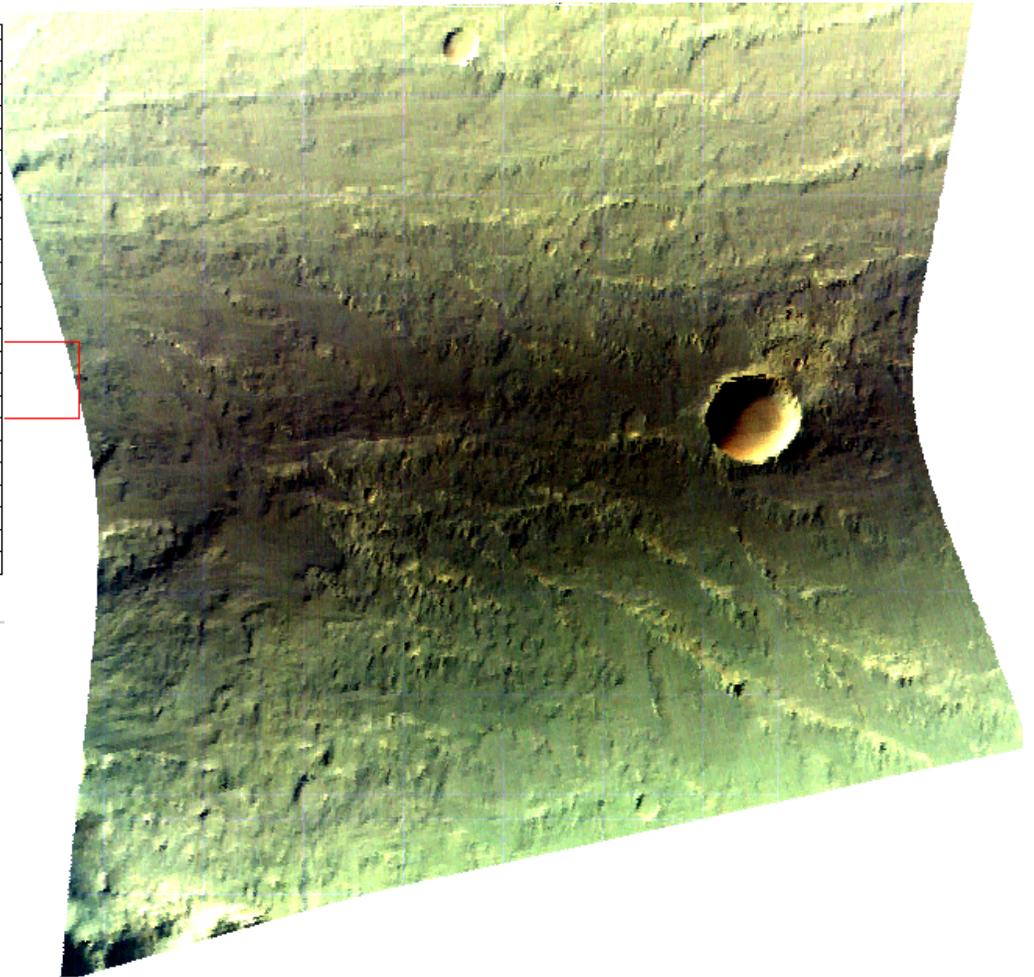
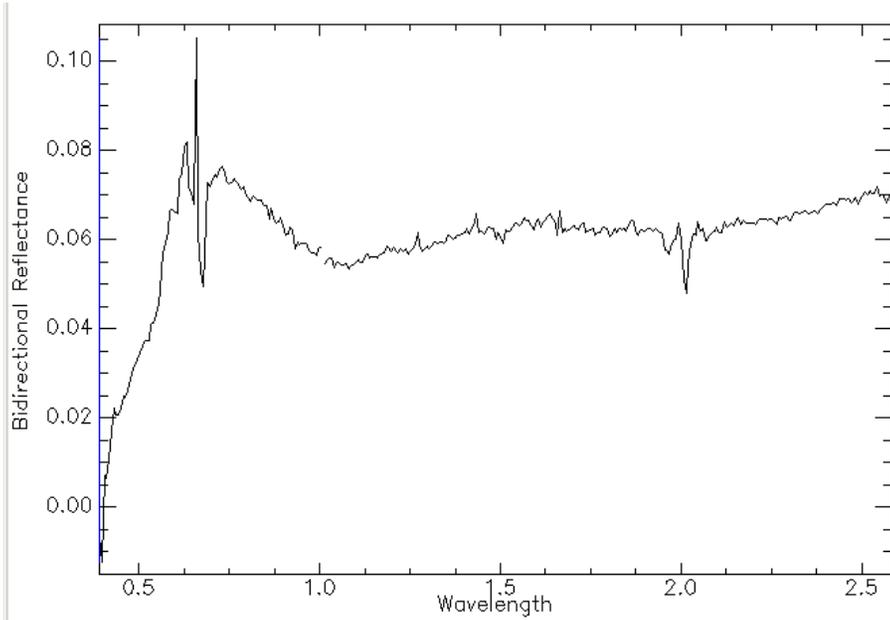
Goal: Relative Abundances



Goal: Relative Abundances



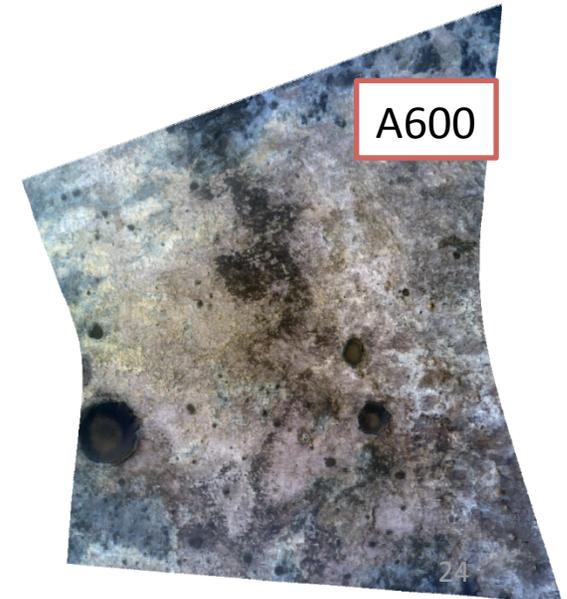
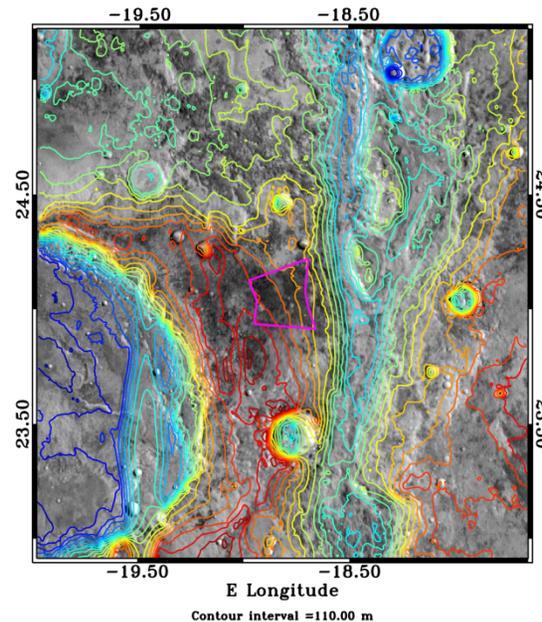
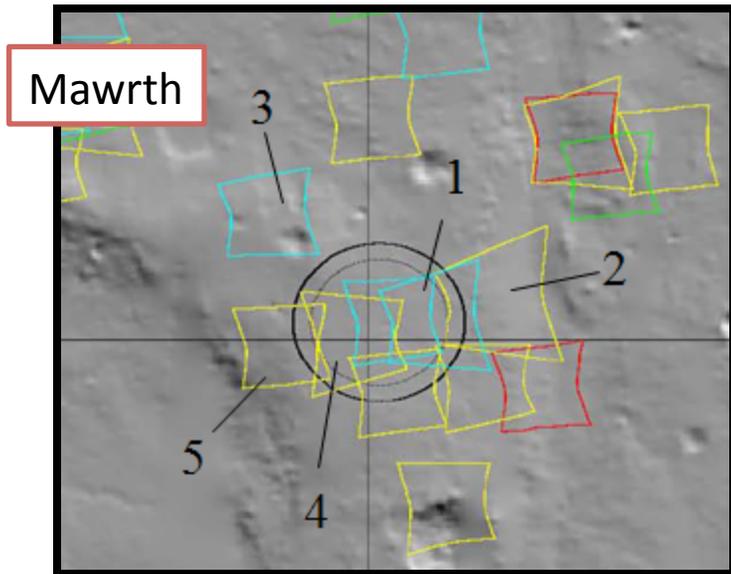
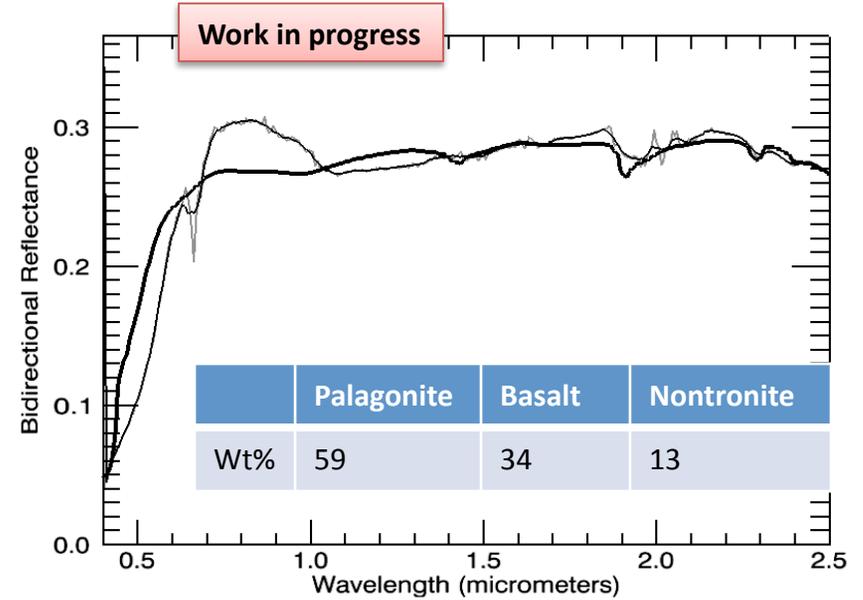
Goal: Relative Abundances



Goal: Relative Abundances

Work to Date:

- Validation of Ratioing
- Preliminary Modeling Results



Work in Progress

- **Continue end-to-end modeling**
 - Additional end members and their optical constants
- **Processing all FRTs over 4 sites**
 - Relative abundance retrievals for all 4 sites

Take-Away Points

- **CRISM should be able to give us abundances and grain sizes of minerals**
 - Requires end-to-end atmospheric/surface modeling + nonlinear mixing model
- **Ratios do work for mineral identification**
- **Our modeling is ongoing on the top FRTs:**
 - Holden – No hydrated/hydroxylated minerals found in top cube yet
 - Mawrth – Strong phyllosilicate signatures seen in top cube
 - Eberswalde - No hydrated/hydroxylated minerals found in top cube yet
 - Gale – Still processing